

# Equipment Condition Report

Overall Diagnosis

# CRITICAL

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Machine ID:	<b>Pump 1</b>	Product (h/km):	Lab Sample N°:	<b>GP706</b>
Application:	<b>Rolls Royce Tennfjord Steering Gear - Hydr system</b>	Machine (h/km):	Label N°:	<b>507981</b>
Make/Type:		Filter (h/km):	Equipment Ref. N°:	<b>LGP643</b>
Cust. Order N°:		System (l):	Sample Taken:	15/09/2014
Product:	Shell Tellus T 32	Top-up (l):	Sample Received:	25/09/2014

GP706

15/09/2014

CRITICAL

## Reported Maintenance:

used lube oil (have been exposed to high temp)

## Comments Oil Condition:

Visual aspect: dark yellow coloured, clear and bright, without visual foreign matter.

The water content is not significant: 117 ppm.

The kinematic viscosity @40°C, 31.73 mm²/s, complies with the mentioned ISO VG32 specification limit.

The kinematic viscosity @50°C is 22.02 mm²/s

The kinematic viscosity @60°C is 15.96 mm²/s

The kinematic viscosity @70°C is 12.00 mm²/s

The kinematic viscosity @100°C is 6.03 mm²/s

The oil's acidity is considered acceptable for this application: 0.42 mgKOH/g.

The ICP spectrometry reveals 6 ppm copper, 4 ppm lead, 5 ppm silicon, 3 ppm iron, in absolute values normally acceptable.

## Comments Machine Condition:

The WPC is used to establish a wear baseline because the WPC remains more or less the same from sample to sample over a period of time as long as a machine is operating normally. The current WPC, 129 is difficult to diagnose without historical data, but is high for a hydraulic system.

The microscopic evaluation of the ferrogram shows that the ferrous wear primordially consists of small rubbing wear platelets, <15 µm.

The what larger ferrous material, including abrasive wear, fatigue chunks and flakes with a maximal diameter of respectively 25,25,20 µm is limited in quantity and size.

Several coloured particles were observed, this indicates heating / high temperatures during generation. Heat treatment @330° C reveals a majority of low alloy steel particles.

The present amount of dark magnetic iron oxides is remarkable, they are indicative for abnormal wear mode.

The non-ferrous wear mainly retains small blank metal particles, not larger than 15 µm.

The amount of system contaminant particles is too high (global severity index of 5) with crystalline particles (dust, sand), lube degradation products, polymeric matter, carbonaceous material and few contaminant spheres up to 5 µm.

## Recommendations:

Without historical data it is difficult to give adequate recommendations, but based on current analysis results we have to consider the overall condition cautiously CRITICAL.

## Equipment Condition Report

Keep under close observation.

It is recommended that this unit is checked for any unusual operating conditions. Monitor temperatures, pressures, noises, filtration, ... as applicable.

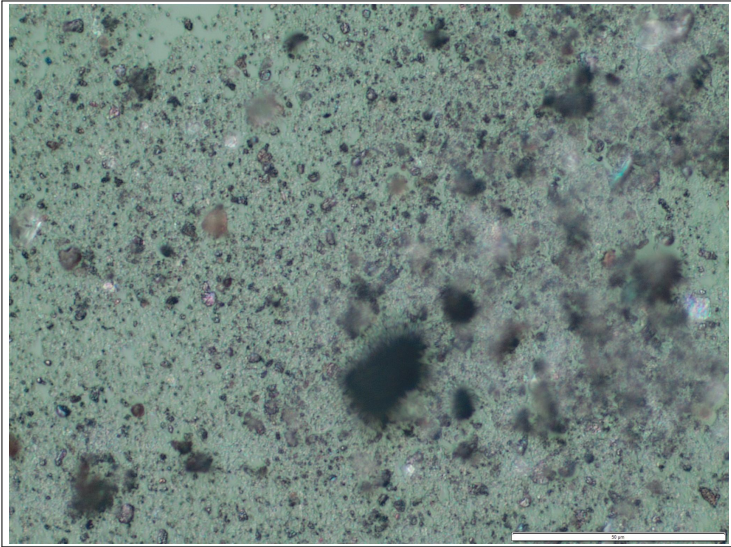
We recommend the efficiency of the system filter is checked.

A preventive oil change is advised.

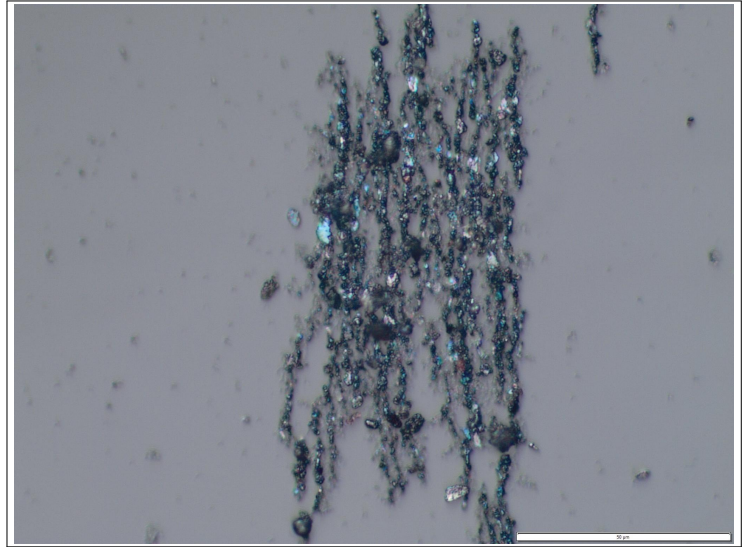
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Test Name	Method	Unit	Results
			GP706
PHYSICAL-CHEMICAL ANALYSIS			
Colour	ASTM-D1500	-	2.5
Visual appearance	OMS 13882	-	clear
Determination of water (KF)	ASTM-D6304	ppm	117
Kinematic Viscosity @40°C	ASTM-D445	mm²/s	31.73
Kinematic Viscosity @100°C	ASTM-D445	mm²/s	6.030
Acid Number (AN)	ASTM-D664	mg KOH/g	0.42
ELEMENTAL ANALYSIS			
Aluminium	ASTM-D5185	ppm	0
Barium	ASTM-D5185	ppm	0
Calcium	ASTM-D5185	ppm	22
Chromium	ASTM-D5185	ppm	0
Copper	ASTM-D5185	ppm	6
Iron	ASTM-D5185	ppm	3
Magnesium	ASTM-D5185	ppm	20
Molybdenum	ASTM-D5185	ppm	0
Sodium	ASTM-D5185	ppm	4
Nickel	ASTM-D5185	ppm	0
Phosphorus	ASTM-D5185	ppm	237
Lead	ASTM-D5185	ppm	4
Silicon	ASTM-D5185	ppm	0
Tin	ASTM-D5185	ppm	5
Zinc	ASTM-D5185	ppm	229
Potassium	ASTM-D5185	ppm	0
WEAR INDEX			
Optical density - large	OMS 13875	-	110.0
Optical density - small	OMS 13875	-	19.0
WPC - Wear Index	OMS 13875	-	129.0
% Large particles	OMS 13875	%	71
ANALYTICAL FERROGRAPHY			
FERROUS			
Rubbing wear	ASTM-D7690	µm max.	< 15
Severe sliding wear	ASTM-D7690	µm max.	
Abrasive wear	ASTM-D7690	µm max.	25
Fatigue chunks	ASTM-D7690	µm max.	25
Fatigue flakes	ASTM-D7690	µm max.	20
Spheres	ASTM-D7690	µm max.	
Dark oxides index	ASTM-D7690	-	4
Red oxides - Rust index	ASTM-D7690	-	2
Corrosive wear	ASTM-D7690	µm max.	< 1
Ferrous wear - Severity index	OMS SWI 2.4	-	4
NON-FERROUS			
White metal alloy wear	ASTM-D7690	µm max.	20
White metal alloy - Severity index	ASTM-D7690	-	2
Copper alloy wear	ASTM-D7690	µm max.	
Copper alloy index	ASTM-D7690	-	
Non ferrous wear - Severity index	ASTM-D7690	-	2
CONTAMINANTS			
Crystalline particles index	ASTM-D7690	-	5
Amorphous particle index	ASTM-D7690	-	1
Friction polymer severity index	ASTM-D7690	-	2
Fibres - Severity index	ASTM-D7690	-	1
Other contaminants index	ASTM-D7690	-	3
Contamination severity index	ASTM-D7690	-	5

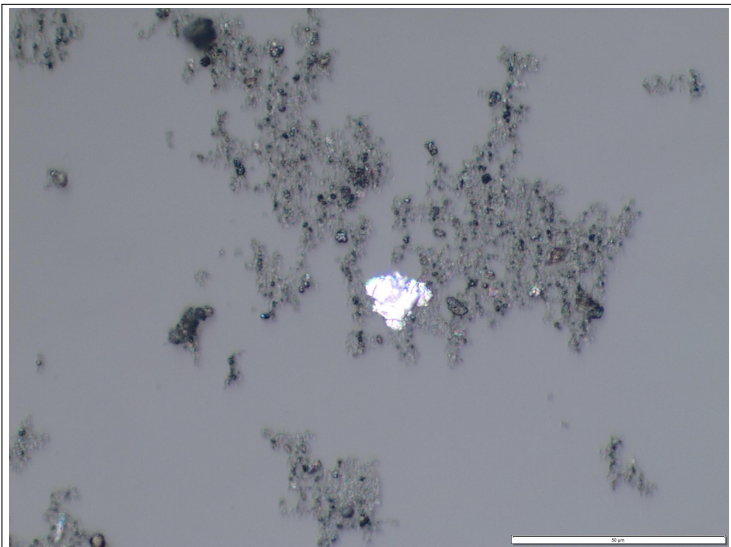
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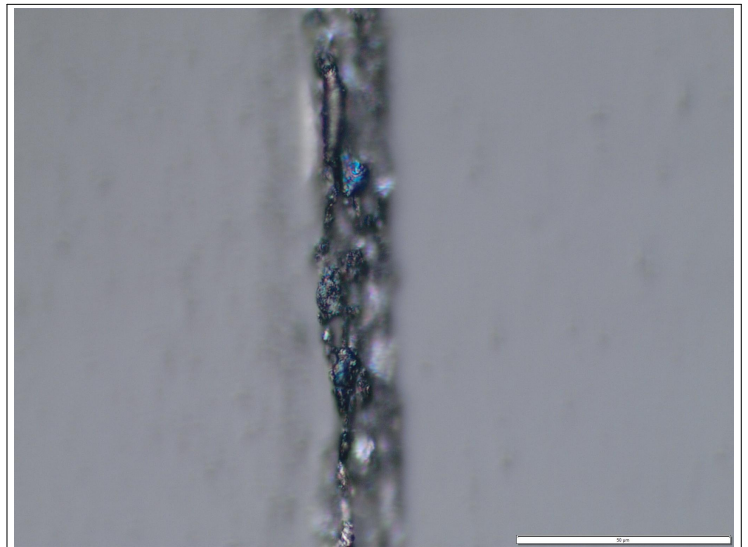
many contaminant particles



small ferrous wear and dark oxides



larger non ferrous blank metal particle



before heating : coloured particles